

[Title of the Document] CLAIMS

[Claim 1]

An intake air amount control system for an internal combustion engine, which variably controls a cam phase of an intake cam shaft for opening and closing an intake valve, relative to a crankshaft by a variable cam phase mechanism, and variably controls a valve lift of the intake valve by a variable valve lift mechanism, to thereby control an amount of intake air drawn into a cylinder of the engine, comprising:

target intake air amount-setting means for setting a target intake air amount to which the amount of intake air is to be controlled, according to a load parameter indicative of load on the engine;

intake air amount-detecting means for detecting the amount of intake air;

first control value-calculating means for calculating a first control value for use in controlling one of the cam phase and the valve lift such that the detected intake air amount converges to the target intake air amount; and

second control value-calculating means for calculating a second control value for use in controlling the other of the cam phase and the valve lift based on the first control value calculated by said first control value-calculating means.

[Claim 2]

An intake air amount control system as claimed in claim 1, wherein the first control value includes a feedback control value for causing the intake air amount to converge to the target intake air amount, and

wherein said first control value-calculating means calculates the feedback control value with a two-

degree-of-freedom control algorithm.

[Claim 3]

An intake air amount control system as claimed in claim 1 or 2, further comprising control input-calculating means for calculating a control input to one of the variable cam phase mechanism and the variable valve lift mechanism according to the first control value, and calculating a control input to the other of the variable cam phase mechanism and the variable valve lift mechanism according to the second control value, and

wherein a calculation period at which said first control value-calculating means and said second control value-calculating means calculate is set to be longer than a calculation period at which said control input-calculating means calculates.

[Claim 4]

An intake air amount control system for an internal combustion engine, which variably controls a cam phase of an intake cam shaft for opening and closing an intake valve, relative to a crankshaft by a variable cam phase mechanism, and variably controls a valve lift of the intake valve by a variable valve lift mechanism, to thereby control an amount of intake air drawn into a cylinder of the engine, comprising:

target intake air amount-setting means for setting a target intake air amount to which the amount of intake air is to be controlled, according to a first load parameter indicative of load on the engine;

intake air amount-detecting means for detecting the amount of intake air;

first control means for controlling the valve lift such that the detected intake air amount converges

to the target intake air amount, and controlling the cam phase with a predetermined first control algorithm so as to assist the valve lift control;

second control means for controlling the cam phase such that the detected intake air amount converges to the target intake air amount, and controlling the valve lift with a predetermined second control algorithm so as to assist the cam phase control; and

control selection means for selecting one of said first control means and said second control means according to a second load parameter indicative of load on the engine, and causing control to be executed by the selected one of said first control means and said second control means.

[Claim 5]

An intake air amount control system as claimed in claim 4, wherein the predetermined first control algorithm for said first control means is an algorithm which controls the cam phase according to a state of control of the valve lift, and

wherein the predetermined second control algorithm for said second control means is an algorithm which controls the valve lift according to a state of control of the cam phase.

[Claim 6]

An intake air amount control system as claimed in claim 4 or 5, wherein said control selection means selects said second control means when the load on the engine indicated by the second load parameter is in a predetermined first load region, and selects said first control means when the load on the engine indicated by the second load parameter is in a predetermined second

load region higher than the predetermined first load region.

[Claim 7]

An intake air amount control system as claimed in claim 6, wherein said control selection means comprises:

acceleration determining means for determining whether or not the engine is in an accelerating state;

load region-determining means for determining that the load on the engine is in the predetermined second load region when the second load parameter is smaller than a predetermined threshold value, while determining that the load on the engine is in the predetermined first load region when the second load parameter is not smaller than the predetermined threshold value; and

threshold value-setting means for setting the predetermined threshold value to a larger value when the engine is determined to be in the accelerating state by said acceleration determining means, than otherwise.

[Claim 8]

An intake air amount control system as claimed in claim 6, wherein said control selection means comprises:

acceleration determining means for determining whether or not the engine is in an accelerating state;

second load parameter-setting means for setting the second load parameter to a larger value when the engine is determined to be in the accelerating state by said acceleration determining means, than otherwise; and

load region-determining means for determining

that the load on the engine is in the predetermined first load region when the set second load parameter is not larger than a predetermined threshold value, while determining that the load on the engine is in the predetermined second load region when the second load parameter is larger than the predetermined threshold value.

[Claim 9]

An intake air amount control system as claimed in any one of claims 4 to 8, wherein each of said first control means and said second control means comprises:

cam phase control value-calculating means for calculating a cam phase control value for use in controlling said cam phase; and

valve lift control value-calculating means for calculating a valve lift control value for use in controlling said valve lift,

wherein said cam phase control value-calculating means calculates the cam phase control value as a sum of a cam phase feedback control value for causing the intake air amount to converge to the target intake air amount, and a cam phase-setting value set according to the valve lift control value,

wherein said valve lift control value-calculating means calculates the valve lift control value as a sum of a valve lift feedback control value for causing the intake air amount to converge to the target intake air amount, and a valve lift-setting value set according to the cam phase control value,

wherein said cam phase control value-calculating means of said first control means sets the cam phase feedback control value to a value of 0 when said first control means is selected by said control selection

means, and

wherein said valve lift control value-calculating means of said second control means sets the valve lift feedback control value to a value of 0 when said second control means is selected by said control selection means.

[Claim 10]

An intake air amount control system as claimed in claim 9, wherein said cam phase control value-calculating means calculates the cam phase feedback control value with a two-degree-of-freedom control algorithm, and

wherein said valve lift control value-calculating means calculates the valve lift feedback control value with a two-degree-of-freedom control algorithm.

[Claim 11]

An intake air amount control system as claimed in claim 9 or 10, wherein said cam phase control value-calculating means sets the cam phase-setting value to such a value as makes earlier the valve-opening timing of the intake valve as the valve lift control value is such a value as makes the valve lift smaller, and

wherein said valve lift control value-calculating means sets the valve lift-setting value to such a value as makes the valve lift smaller as the cam phase control value is such a value as makes earlier the valve-opening timing of the intake valve.

[Claim 12]

An intake air amount control system as claimed in any one of claims 9 to 11, further comprising control input-calculating means for calculating a control input to said variable cam phase mechanism according to the cam phase control value, and calculating a control

input to said variable valve lift mechanism according to the valve lift control value, and

wherein a calculation period at which said cam phase control value-calculating means and said valve lift control value-calculating means calculate is set to be longer than a calculation period at which said control input-calculating means calculates.